

REMARKS/ARGUMENTS

Claims 13-15, 23-24 and 27 are active in this application, Claims 1-12 having been canceled and claims 16-22 and 25-26 being withdrawn by the Examiner due to restriction. Claims 14, 15 and 24 have been amended to remove the term “type”. This amendment is supported by the claims as originally filed. No new matter has been added by this amendment.

The present invention relates to a formal or acoustic insulation product based on mineral fibers and comprising at least 1% by weight of a cured organic resin. The product is required to release less than 50 mg/kg of formaldehyde and less than 50 mg/kg of methyl isocyanate when heated to 350°C for at least 15 minutes and the product is required to be usable at temperatures above 150°C. Applicants provide herewith an excerpt from “Phenolic Resins” which provides further information regarding the difference between insulation products such as the thermal or acoustic insulation product and one of the products such as those in the prior art cited by the Examiner. In particular, products that are insulation products comprise mineral wool fibers and an organic resin which locks intersecting fibers into a mass by bonding the fibers as they cross an overlay. Such products are normally bulky and voluminous and are compressed into packages for shipment and sale. However, once the package is opened the insulation product regains its original thickness after unfolding. The organic resin provides the ability to have the fibers locked together but having flexibility in the final product.

Claims 14-15, 23-24 and 27 stand rejected under 35 U.S.C. § 102(b) over Marchetti et al. (Applicants note that the rejection omits claim 13, but the arguments are based on claim 13, as all of the rejected claims depend from claim 13. Accordingly, if Claim 13 is not rejected, then all claims are allowable as being dependent on an allowable claim.) Marchetti et al. discloses flame retardant B staged epoxy resin prepregs and laminates from these. In

particular, these prepregs are glass cloth laminates which are impregnated with epoxy resin and used in the printed circuit industry to make high grade copper clad circuit boards (see column 1, lines 7-9). The prepregs of Marchetti are formed by impregnating the resin composition into a porous substrate such as paper or fibrous glass cloth and then heated to provide a dry, but not completely cured, prepreg. These prepregs are then stacked in a press and cure laminated to make laminates of multiple layers. As disclosed in Marchetti, as well as in the attached paper from "Phenolic Resins", these laminates are used in the manufacture of printed circuit boards with the laminate being a thin, nonporous and relatively homogenous material. Such a structure cannot suggest the thermal and/or acoustic insulation product of the present invention since the phrase "thermal insulation or acoustic insulation" as used in the present invention has a defined meaning in this art and cannot be confused with a laminate as taught by Marchetti et al., which is a rigid dense structure containing amounts of resin, as commented by the Examiner, on the order of 75% or greater of the final product. Such a product would not function as a thermal or acoustic insulation product as required in the present claims and one of ordinary skill in the art would not see these two different items as being related.

As noted in the attached article, laminates for the electrical and electronic industries are prepared by impregnating the inorganic fiber fabric carrier material with a phenolic resin or other liquid thermosetting binder, drying the impregnated webs (see Figure 6.57 of the attached article) and then cutting them to sections of specific dimension (see Figure 6.58). After the impregnated material has been cut to size and stacked it is then subjected to hot compression in a press (Figure 6.58). Accordingly, the three most important operations of the process are (1) impregnation or saturation of the carrier material, (2) drying coupled with pre-curing of the heat reactive binder and (3) final curing in a press. The obtained laminate is thus a thin non-porous and relatively homogenous material. As shown in the figures of

Marchetti as well as throughout the specification of Marchetti, their laminate products are essentially the same as those defined in the Phenolic Resins reference attached. Accordingly, Marchetti cannot anticipate the present invention and cannot render it obvious as the material of Marchetti could not be seen by one of ordinary skill in the art as meeting the requirements of a thermal and/or acoustic insulation product. Accordingly, this rejection should be withdrawn.

The claims stand provisionally rejected for obviousness-type double patenting over Claims 1, 4, 13-15 and 17-18 of co-pending application 10/578,571. The claims of the co-pending application cannot render the claims of the present invention obvious as the only relationship between the claims of the co-pending application and that of the present invention is that the co-pending application claims a sizing composition for insulation products which happens to have an epoxy resin of a glycidyl ether present. However, the co-pending application claims require additional components which are not required in the present invention and the co-pending application claims make no suggestion regarding the required maximum levels of release of formaldehyde or methyl isocyanate required in the present invention upon heating to 350°C.

Additionally, Applicants note that the present application is based upon a PCT application of July 9, 2003 and was filed in the United States August 31, 2005 well before the U.S. filing date of the co-pending application and having a PCT filing date prior to the co-pending application's PCT filing date. Since the claims of the co-pending application have not been allowed, and in fact have not received an official action, the Examiner is requested to follow the procedures set forth in the MPEP in allowing the present application to pass to issue and make a corresponding obviousness-type double patenting rejection in the co-pending application, if applicable or appropriate.

Claims 14-15, 24 and 27 stand rejected under 35 U.S.C. § 112, second paragraph.

This rejection has been obviated by the present amendments.

Applicants submit that the application is now in condition for allowance, and an early Notification of such action is earnestly solicited.

Respectfully submitted,

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A handwritten signature in black ink, appearing to read "J. Derek Mason", is written over a horizontal line.

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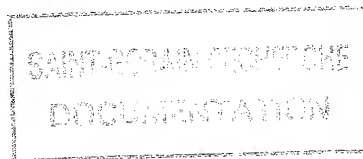
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Phenolic Resins

Chemistry, Applications,
Standardization, Safety and
Ecology

2nd completely revised edition

With 309 Figures and 166 Tables



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Preface

A backward glance at the 20th century world economy. The plastics industry made its debut with Baekeland (1869).

He discovered the manufacture of highly cross-linked oligomeric phenolics.

Today phenolics are commercially available in a wide variety of forms. They are distinguished by their properties as thermoplastic or thermosetting synthetic fibers.

As "plastics" which are part of a system and the easily identified composites, honeycomb coatings, wood-borne resin identity is lost. The apparent high friction linings of components including phenolic resin is. During the braking process converted into heat on the surface of the vehicle. Through complementary management of phenolic brake is best described.

The main objective with phenolic resin

Table 6.19. "R" values for various insulation materials: "R"-value^a, thickness in cm

Insulation material	λ	K-Factor ^b	7	5.3	3.5	1.8	Maximum Service Temp °C
Phenolic	0.017	1.73	12.2	9.1	6.1	3.0	150
PUR/PIR ^c	0.026	2.60	18.3	13.7	9.1	4.6	125
Extruded polystyrene	0.029	2.88	20.3	15.2	10.2	5.1	75
Expanded polystyrene	0.035	3.46	24.4	18.3	12.2	6.1	75
Glass fiber	0.040	4.03	28.4	21.3	14.2	7.1	450
Mineral fiber	0.050	5.04	35.6	26.7	17.8	8.9	450
Perlite	0.056	5.62	39.6	29.7	19.8	9.9	-
Vermiculite	0.069	6.91	48.8	36.6	24.4	12.2	-

^a $\text{m}^2 \cdot \text{K}/\text{W}$.^b $(\text{W} \cdot \text{cm})/\text{h m}^2 \cdot \text{K}$.^c Polyurethane/polyisocyanurate.

The "R" values protocol was developed in North America and is related to the thickness of insulation material (in inches). It is the reciprocal of the K factor (thermal conductivity) whose units are $\text{BTU} \cdot \text{in}/\text{h} \cdot \text{ft}^2 \cdot ^\circ\text{F}$. R values of 10, 20, 30, and 40 were tabulated with corresponding foam thicknesses. These R values were applicable to different geographical regions of North America. Recommended R values for ceilings/walls/floors for Chicago are listed as R 33/19/22 respectively while for New York values are R 30/19/19. Thus polyurethane/polyisocyanurate (PUR/PIR) foam thickness for Chicago would be 5.4/3.4/4 (inches) and for New York 5.4/3.4/3.4 (inches). These values and thicknesses were guidelines for the home construction industry to use sufficient foam thickness or inorganic materials for satisfactory home and warehouse insulation in ceilings/walls/floors. By examining the R value table, North American builders could determine the thickness of insulation for ceiling/wall/floor that would be suitable and could specify the type of material (foam or inorganic material).

R values listed in Table 6.19 relate to the metric system with arbitrary R values of 7, 5.3, 3.5, and 1.8 which equate to 40, 30, 20, 10 R values (in U.S. units) and indicate insulation thicknesses in cm. Thus phenolic foam is the most effective thermal insulation material while vermiculite is the least with glass fiber/mineral wool intermediate.

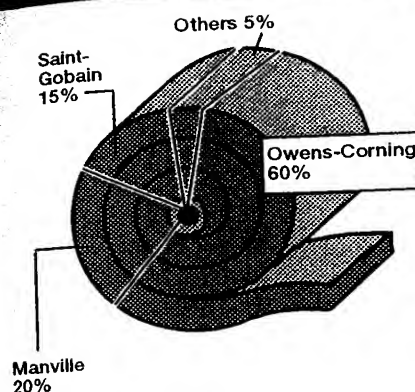
Market share and companies involved with inorganic fibers for building insulation in North America and Europe are shown in Fig. 6.8. Volume of inorganic fibers continues to be greater than polymeric foam materials (Table 6.20).

6.1.2.1.2

Types of Inorganic Fibers

Inorganic fiber-based products that are transformed into thermal insulation consist of either glass or mineral wool fibers. Different continuous processes

NORTH AMERICA

**Fig. 6.8.** Market share for North America fibers for insulation (1993)**Table 6.20.** Volume of insulation materials in Europe (1994)

Material
Mineral wool
Polystyrene
Polyurethane
Miscellaneous

[2] are involved whereby the melt furnace is divided into stream collected in a felted irregular manner. Thus, thermal insulation comprising glass, rock wool, or resinous binder of 5–20 wt% to preserve insulating, acoustic and fire-retardant properties.

The most commonly employed binder is a soluble, easily blended with other to low concentrations which are required amount of binder for most thermal insulation. "lock" intersecting fibers into a network overlay. Binder compositions show the binder solution can be applied in sections. Glass fiber insulation materials (3–6 μm) are bonded with glass fiber and provide flexibility and thickness after unfolding the com-

s, and Six Bonding Functions

"R"-value^a, thickness in cm

5.3	3.5	1.8	Maximum Service Temp °C
9.1	6.1	3.0	150
13.7	9.1	4.6	125
15.2	10.2	5.1	75
18.3	12.2	6.1	75
21.3	14.2	7.1	450
26.7	17.8	8.9	450
29.7	19.8	9.9	-
36.6	24.4	12.2	-

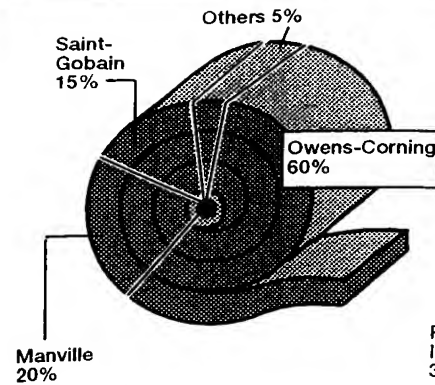
n North America and is related to (ches). It is the reciprocal of the K are $\text{BTU} \cdot \text{in}/\text{h} \cdot \text{ft}^2 \cdot ^\circ\text{F}$. R values of 10, bonding foam thicknesses. These R physical regions of North America. /floors for Chicago are listed as R values are R 30/19/19. Thus poly-am thickness for Chicago would 5.4/3.4/3.4 (inches). These values some construction industry to use materials for satisfactory home and ors. By examining the R value table, ne the thickness of insulation for id could specify the type of material

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NORTH AMERICA



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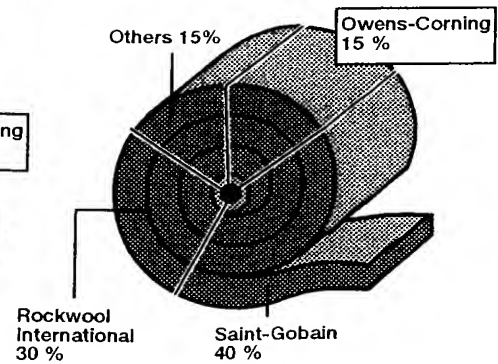


Fig. 6.8. Market share for North America and European companies engaged in inorganic fibers for insulation (1993)

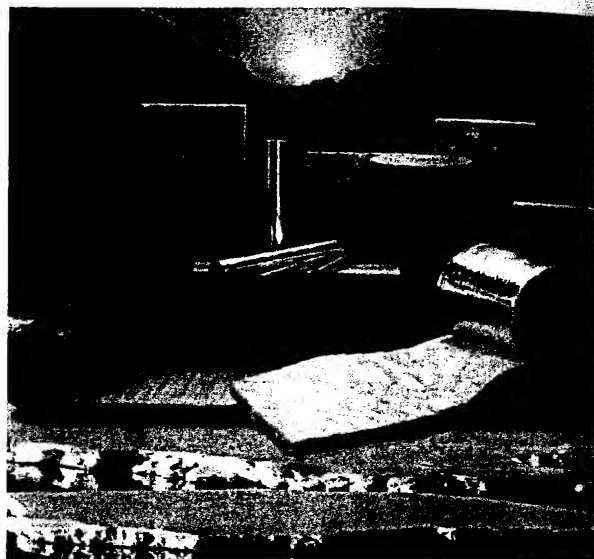
Table 6.20. Volume of insulation materials in Europe (1994)

Material	Volume (million m ³)
Mineral wool	55.1
Polystyrene	21.3
Polyurethane	3.9
Miscellaneous	3.0

[2] are involved whereby the molten inorganic composition flowing from a melt furnace is divided into streams and attenuated into fibers. The fibers are collected in a felted irregular manner to form a mat. To produce most thermal insulating products, the fibers must be bonded together in an integral structure. Thus, thermal insulation batts, acoustical tiles, and similar structures comprising glass, rock wool, or other mineral fibers are held together by a resinous binder of 5–20 wt% to provide strength and resiliency to the structure and preserve insulating, acoustical, and dimensional properties.

The most commonly employed binder is phenolic resin which is water soluble, easily blended with other components (urea, silane, etc.), and diluted to low concentrations which are readily sprayed onto the fiber. The optimum amount of binder for most thermal insulation products should be sufficient to "lock" intersecting fibers into a mass by bonding the fibers as they cross or overlay. Binder compositions should exhibit good flow characteristics so that the binder solution can be applied in low volume and flow into the fiber intersections. Glass fiber insulation materials comprising very small diameter filaments (3–6 μm) are bonded with phenolic resins to reduce the brashness of glass fiber and provide flexibility to the fibers as they regain their original thickness after unfolding the compressed glass fiber material from its packag-

Fig. 6.9. Glass wool insulation products, Pfleiderer, Delitzsch, Germany



ing container. Brashness is associated with dust and breakage of filaments during handling and shipping. Cured glass fiber/binder compositions are normally very bulky and voluminous. Batts and rolls used as insulation in buildings have densities ranging from 8 to 16 kg/m³ and require binder content of 3–7 wt%. Since it is expensive to ship bulky materials in an uncompressed state, batts and rolls are bundled and compressed in packages 8–25% of manufactured thickness. Once unfolded the material should recover to 100% of its original volume. Insulation materials not achieving these recovery values would have difficulty meeting advertised thermal resistivity (R) values. Methods are available to fiber glass manufacturers that determine the amount of binder present by loss on ignition test (LOI) which should be greater than 4%. With LOI determinations combined with photomicrographs, one can determine binder junction quantity (μ^2) and relate to recovery of the material on unfolding.

Different types of glass fiber compositions are shown in Fig. 6.9.

6.1.2.1.3

Resins for Inorganic Fibers

Highly water soluble resole resins are prepared by reacting phenol with an excess of formaldehyde at temperatures below 70 °C. The F/P ratio is usually 3.5–4.0:1. Generally alkaline earth hydroxides (calcium or barium) are used as catalysts. High quality resins are normally ash free with catalyst precipitated as carbonate or sulfate and removed by filtration.

Excess F, as much as 7%, is available to react with urea to a urea extended resole. Not only does urea react with F but it may [3, 4] undergo a co-conden-

Table 6.21. Phenolic resins binders for inorganic fibers

	PF resin (modified for mineral fibers)
Refractive index	1.4610
Solids content (%)	48.0
Viscosity (mPa·s)	<25
Water dilutability	∞
pH	8.8
Free phenol	<0.5
Free formaldehyde	0.4
Density g/cm ³	1.175
B-time (130°) min	9

sation reaction with methylol phenol. Urea extended PF binders are more costly than urea extended PF binders due to some loss in properties as urea conversion is not 100%. Urea extended PF binders, especially after storage under humid conditions, show a significant loss in properties. Properties of phenolic resin binders are contained in Table 6.21 [5].

6.1.2.1.4

Resin Formulation

The resin is applied as a 10–15% solution in water. The resin is applied as a 10–15% solution attributable to the presence of main bonding species being trimethylol phenol components.

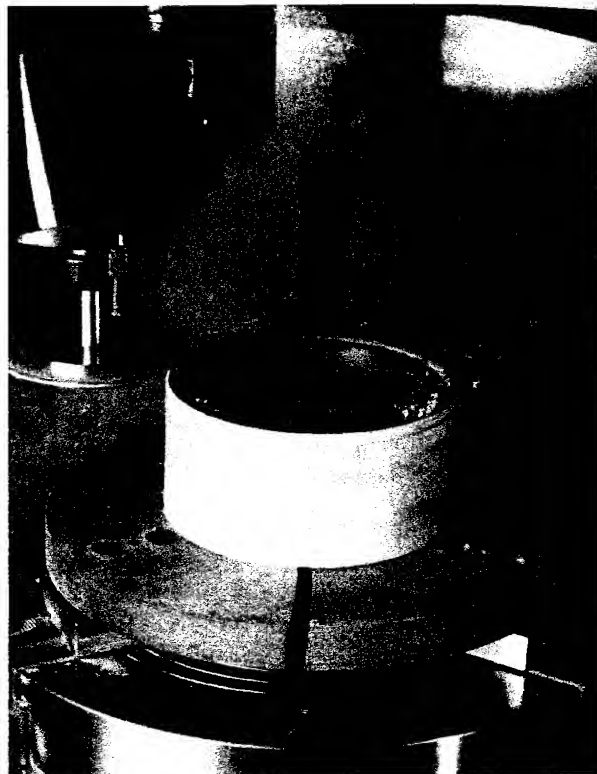
Composition for treatment of fibers

- 100 pbw phenolic resole
- 7 pbw 20% ammonia solution
- 0.02 pbw amino silane (γ -aminopropyltrimethoxysilane)
- 0–800 pbw water

Ammonia reacts with free F and formaldehyde as well as pH adjustment to a coupling agent to improve the mechanical strength. Urea is added to the resin immediately prior to use by the glass fiber manufacturer. Urea salts are additives to improve PF/binder properties.

Properties of mineral fiber materials

Fig. 6.55. Working of a paper-based laminate tube
(Photo: Isola AG, Düren)



Most of these materials are used as insulating materials in the electrical industry and in data systems engineering, and must exhibit an outstanding range of mechanical and electrical properties matched to the resin matrix. Many special-purpose unmodified and modified phenolic resins have thus been developed for these application areas. The modifiers that are used mainly affect the flame retardancy, flexibility, or plasticity, allowing the product to function under special processing conditions [10–13]; i.e., they exert a specific effect on the fabrication, processing and end-use application. Among molded laminates, paper-based and fabric-based laminates represent some of the most important products [14]. Their low density, good electrical properties, and outstanding workability are noteworthy.

6.1.4.2

Molded Laminates (Survey of Technologies and Diversification)

Fabrication of molded laminates using thermosetting resins is accomplished by impregnating the fabric or paper carrier materials with phenolic resins or

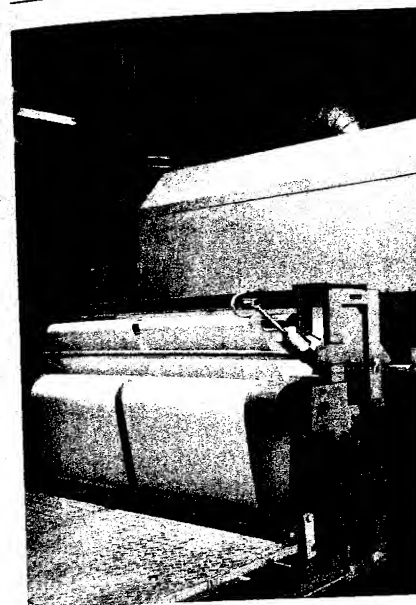


Fig. 6.56. Horizontal impregnating system

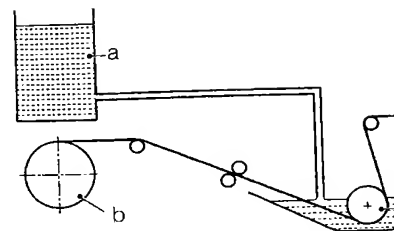


Fig. 6.57. Impregnation of carrier material
c = impregnation; d = drying; e = coiling

other liquid thermosetting bir (Figs. 6.56 and 6.57), drying the i cutting them to sections of spec nation systems operate horizont nating and drying technology i modern vertical systems equip ers are used for cotton fabric an nated glass laminates.

The drying sections represen line. Various drying systems are



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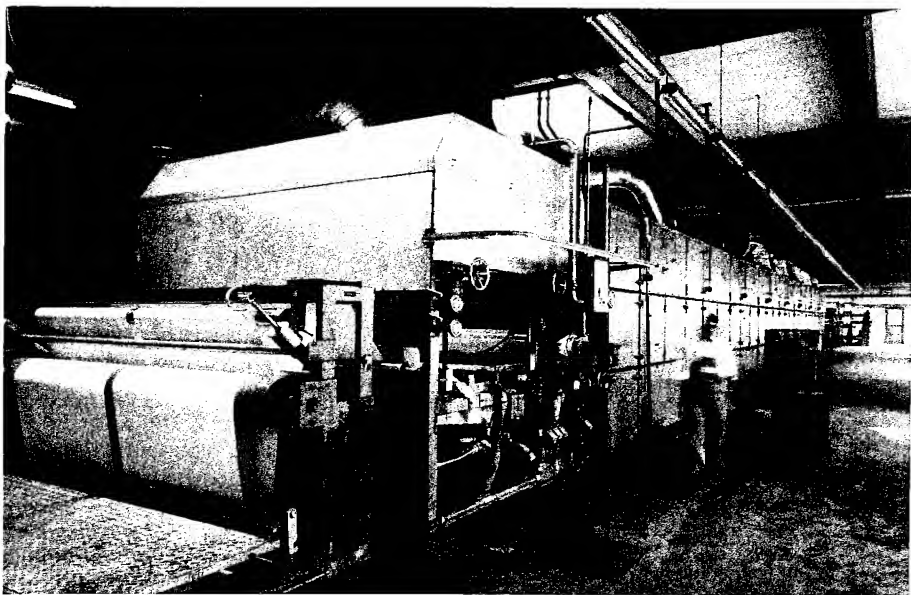


Fig. 6.56. Horizontal impregnating system for paper-based laminates

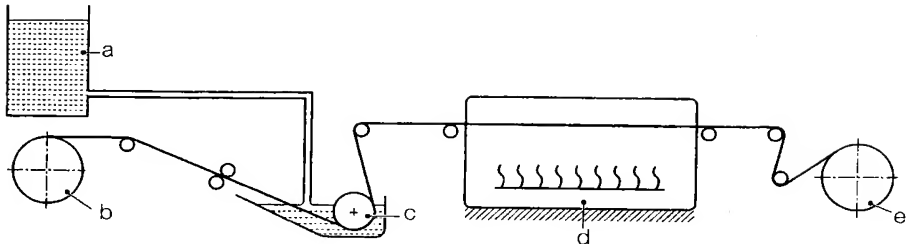


Fig. 6.57. Impregnation of carrier materials (a = impregnating bath; b = carrier web feed; c = impregnation; d = drying; e = coiling of impregnated web) (from [10])

other liquid thermosetting binders such as melamine resins or epoxies (Figs. 6.56 and 6.57), drying the impregnated webs in a festoon dryer, and then cutting them to sections of specific dimensions (Fig. 6.58). Industrial impregnation systems operate horizontally or vertically [15–17]. Horizontal impregnating and drying technology is mainly used for phenolic paper laminates; modern vertical systems equipped with strategically positioned radiant heaters are used for cotton fabric and particularly for high-quality, epoxy-impregnated glass laminates.

The drying sections represent the most important part of the impregnation line. Various drying systems are used, and particular care is devoted to tempe-

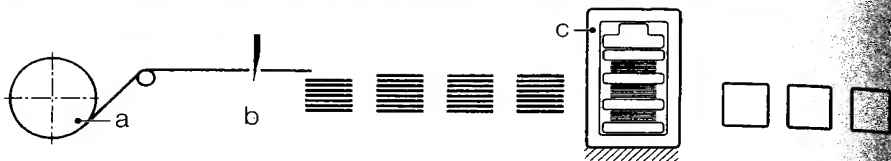


Fig. 6.58. Further processing of impregnated carrier materials to afford molded laminate (a = impregnated carrier material; b = cutting to size; c = stage press) (from [10])

perature control since it must be possible to set a temperature or temperature program that best corresponds to the individual curing characteristics of the resin system. The ideal temperature program may be empirically determined.

Continuous double belt presses can also be used to press the impregnated webs of carrier material. In these, the impregnated webs of material are continuously pressed and cured between two steel belts. Such a technique requires rapidly curing resin systems. This process, which is suitable for thin materials exhibiting a homogeneous formulation and quality, is used on a large scale for decorative laminates and to a lesser extent in the area of thin epoxy glass fabric laminates.

After the impregnated material has been cut to size and stacked, it is subjected to hot compression in multi-daylight presses (Fig. 6.58). The layers are converted into a relatively homogeneous material by pressing at a temperature of 150–160 °C. The phenolic resins cure during this process (position c in Fig. 6.58). The layers should not delaminate during working or subsequent use.

The three most important operations in production of molded laminates are thus (1) impregnation (saturation) or coating of the carrier material, (2) drying (evaporation of solvents and water) coupled with precuring of the heat-reactive binder, and (3) final curing in presses [18].

Vulcanized fiber (made using stacks of parchmentized paper as a starting material) can be regarded as a precursor to molded laminates [19]. Today, the main use of vulcanized fiber itself is in production of vulcanized fiber wheels (cf. sections on coated abrasives).

Molded laminates also include the laminated profiles and tubes mentioned above. Tubes can be produced by winding impregnated webs around a mandrel (positions b and c in Fig. 6.59) and compacting these, if appropriate, with secondary shaping. Secondary shaping can afford profiles such as angles or flat bars (positions f and e in Fig. 6.59) (see also Filament Winding in High Performance and Advanced Composites Section 6.1.5).

In the winding process for fabrication of tubes, impregnated or coated carrier materials (paper or fabric) are heated by passing them over a system of rollers, wound around a heated mandrel, and the uncured shape on the mandrel cured by application of additional heat. The winding machines used for this purpose can be constructed using various systems (two-roll or three-roll machines). Another fabrication method is used to manufacture compression shaped tubes and profiles, and has the advantage that the material is subjected to less stress (during stripping). In compression shaping, the web is wrapped

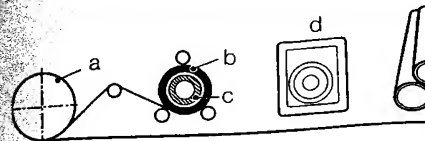


Fig. 6.59. Further processing of impregnated (a=impregnated carrier material; b=coiling; c=pressing; d=pressing; e=profile winding system; f=press

around the mandrel in either a cold
ped mandrel (of any desired cross-s
to its profile. Pressing is then carried
pressure appropriate to the molded
also be compression shaped to yield

6.1.4.3

6.1.4.3 Economic Considerations and Background (and Printed Circuit Boards)

Unclad and copper-clad base materials have by far the greatest importance of molded laminates, particularly in the entertainment industry and the computing computers and television sets.

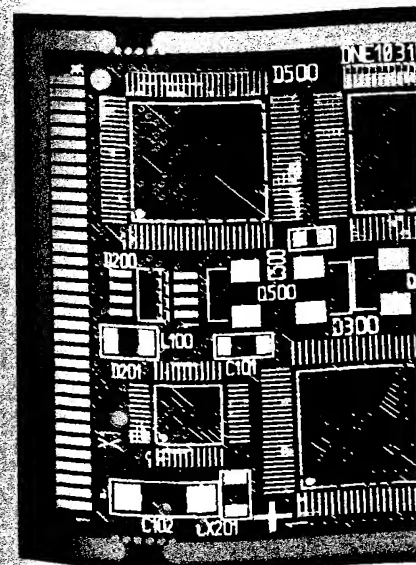
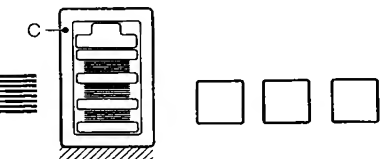


Fig. 6.60. Printed circuit board withou



materials to afford molded laminates
c = stage press) (from [10])

set a temperature or temperature
dual curing characteristics of the
may be empirically determined.
be used to press the impregnated
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material by pressing at a temperature
uring this process (position c in
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production of molded laminates
oating of the carrier material, (2)
) coupled with precuring of the
presses [18].
archmentized paper as a starting
molded laminates [19]. Today, the
duction of vulcanized fiber wheels

ated profiles and tubes mentioned
impregnated webs around a man-
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by passing them over a system of
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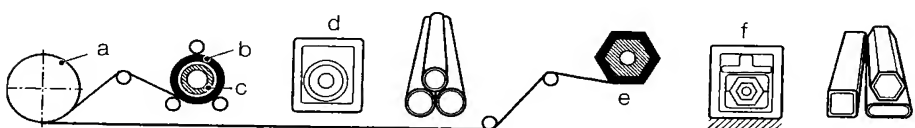


Fig. 6.59. Further processing of impregnated carrier materials to afford profiles and tubes
(a = impregnated carrier material; b = coiling of impregnated web; c = mandrel; d = heat
curing; e = profile winding system; f = pressing) (from [10])

around the mandrel in either a cold or moderately warm state, and the wrap-
ped mandrel (of any desired cross-section) placed in a mold that corresponds
to its profile. Pressing is then carried out under conditions of temperature and
pressure appropriate to the molded laminates. The round or angular tubes can
also be compression shaped to yield flat bars or profiles.

6.1.4.3
Economic Considerations and Background (Electrical Laminates
and Printed Circuit Boards)

Unclad and copper-clad base materials for printed circuit boards (Fig. 6.60)
have by far the greatest importance in the areas of fabrication and application
of molded laminates, particularly in view of the boom in the electronics and
entertainment industry and the corresponding demand for products includ-
ing computers and television sets.

